THE CLASSIFICATION OF PLANTS, I.

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It is the intention of the writer to give from time to time, for the use of students, a series of notes on the classification of plants. The disposition made of the plant kingdom will represent the writer's own views although much has been borrowed from various sources.

The classification of the plant kingdom should be an expression of its evolutionary history so far as known or it should at least be an attempt at such an expression. It should be based on the doctrine of descent. A natural arrangement should take account of the progressive advancement of plants from the lowest to the highest types as well as of the segregation of great branches or groups and the origin of large numbers of species belonging to the same general level. In other words, the scheme should

include the recognition of both vertical and horizontal developments. In a general way the morphological characters which represent the progress from unicellular to the most complex multicellular forms are of very great importance in placing any group of organisms in the scale. But of still greater importance is the character of the life cycle.

If all types of plants evolved in the past had remained to the present day, it would be possible to devise a scheme which would show the natural relationships of all species and larger groups by very close connecting links. But in the evolutionary process plants passed through critical stages where it was hardly possible for them to tarry. The species must either remain below the critical condition or else advance farther in order to meet the requirements of the newly acquired structures, habits, or functions. The changing conditions of the earth's surface have had a profound effect as well as the mere fact of a great diversity of conditions. One of the most important factors in the problem of classification arises out of the changing environments to which plants were subjected during the geological history of the earth. In finding a basis for the determination of evolutionary advancement or retrogression, therefore, the ecological factor also becomes one of great importance. The change of functions and activities in passing from one set of conditions to another is sometimes considerable. As one would expect, then, there are breaks in the continuity of plant groups and these breaks frequently mark the transition to life in a different environment.

There are two very important gaps which divide the entire plant kingdom, as we have it at present, into three distinct groups. Each succeeding group is in all essentials more highly developed than the preceding and shows no very close relationship to it, the intermediate forms having been lost. These three groups may be called series and we can then say that the plant kingdom is divided into three series.

The first great hiatus occurs at the point where plants adapted to a water habitat passed out to aerial conditions. It represents the grand transition from water to aerial moist ground plants. This transition must, however, not be confused with those cases where plants having a body adapted to a water condition, typically filamentous in form, merely changed sufficiently to *endure* an aerial habitat.

The second great hiatus marks the boundary line between those plants, on the one hand, which are still dependent on considerable moisture for one generation and on the presence of free water to accomplish fertilization and the plants, on the other hand, which have been practically weaned from the necessity of free water during any period of their life cycle. In these highest

dryland plants the water taken from the soil into the body of the plant is sufficient for carrying on all the essential processes of life.

From certain morphological characteristics the three great groups or series have been called THALLOPHYTA, ARCHEGONIATA, and SPERMATOPHYTA, or in English, Thallophytes, Archegoniates, and Spermatophytes or Seed Plants. It must not be supposed, however, that all plants live in the habitat to which they seem to have been adapted originally. The great majority of Thallophytes now live in the air, many Archegoniates are found in very dry places, while great numbers of Seed Plants have returned to the water.

The general progress of the history of the earth's surface has been from an aqueous condition to a dry land condition. Plants originated in the water and since islands and continents arose from the primordial ocean they have been stranded on the shores and crowded from water to aerial conditions by the drying of swamps and seas. When drier conditions began to prevail on the enlarging islands and continents, the lack of free water was met by the development of seeds. The progressive advancement of the general mass of the plant kingdom has plainly been along the lines of the earth's physiographic history. It must not be concluded however, that the evolution of plants was entirely or even to a considerable extent due to environment but only that the evolutionary process has kept pace with physiographic changes on the earth. The evolutionary processes are primarily the result of protoplasmic properties and functions. Organisms in the past were as well adapted to live in their environment as organisms are at present; and from a geological point of view it becomes evident that evolution has been making its way through the conditions of environment from the beginning. Generalized or archaic types are usually as rare in fossil groups as among living forms. As for example in various groups of gymnosperms, the first known forms are as highly specialized as any which come later. It is probably safe to say that the conditions of environment may and do act as determinative factors in the evolutionary process but they are not the cause of the process.

The three series of plants may be characterized as follows:

A. THALLOPHYTA. Thallophytes. 60,000 known living species.

The lowest plants; typically water plants but the majority now without chlorophyll and living as parasites or saprophytes in aerial conditions; plant body a thallus, unicellular, cœnobioid, or multicellular, usually filamentous, very minute to gigantic in size; all gradations from the lowest nonsexual plants to plants with complete sexuality and often with an alternation of generations but the sporophyte or nonsexual generation always small and not typically developed, the gametophyte being *the* plant; oosphere when present never produced in an archegonium but in a simple oogonium.

B. ARCHEGONIATA. Archegoniates. 15,000 known living species.

The intermediate plants; normally aerial plants but moisture-loving; always with an alternation of generations, the gametophyte comparatively large and often hermaphrodite in the lower forms but minute and always unisexual in the highest; the sporophyte small and without vascular tissue and permanently parasitic in the lower forms but large and with vascular tissue and becoming independent when mature in the higher; either homosporous or heterosporous, eusporangiate or leptosporangiate, never seed-producing; growing point commonly with a definite, two- or three-sided apical cell; stems sometimes having secondary thickening by means of a more or less perfect cambium or by division in the cortical cells; oosphere produced in an ovary of definite character called an archegonium and always cutting off a ventral canal cell; fertilization asiphonogamic, the spermatozoids swimming through water.

C. SPERMATOPHYTA. Seed Plants. 125,000 known living species.

The highest plants; normally dry land plants; always with an alternation of generations; sporophyte large, heterosporous and eusporangiate, the spores not discharged; the gametophytes usually minute, developing in the sporangia and thus parasitic on the sporophyte; female gametophyte, with an archegonium which develops an oosphere and ventral canal cell or with only a rudimentary ovary, retained permanently in the megasporangium (ovule); male gametophytes (pollengrains) at length discharged from the microsporangium (pollensac) but having a second period of parasitic growth by the formation of a pollentube, hence fertilization always siphonogamic; male cells usually nonciliated but in the lowest classes developing into multiciliate, motile spermatozoids; plants producing seeds, the sporophyte embryo passing into a resting stage intervening between its intra- and extra-seminal development; stems without true apical cells, but more commonly with a cambium zone from which secondary thickening takes place.